電工學小考 (Chapters 1 and 2)

10/25/2006

1. (a) The power delivered to the device is

$p_{ab}(t) = v_{ab}(t) \cdot i_{ab}(t) = 5A \cdot 10\sin(200\pi t)V = 50\sin(200\pi t)W.$

(b) The energy delivered to the device from t=0 to t=10ms is

$$w = \int_{t=0}^{t=10ms} p_{ab}(t)dt = \int_{t=0}^{t=10ms} 50\sin(200\pi t)dt = \frac{50}{200\pi}\left(-\cos(200\pi t)\right)\Big|_{t=0}^{t=10ms}$$

$$= \frac{-1}{4\pi}\left(\cos(2\pi) - \cos(0)\right) = \frac{-1}{4\pi}(1-1) = 0J.$$

2. (a) A super node is formed by drawing a dashed line enclosing several nodes and any elements connected between them.

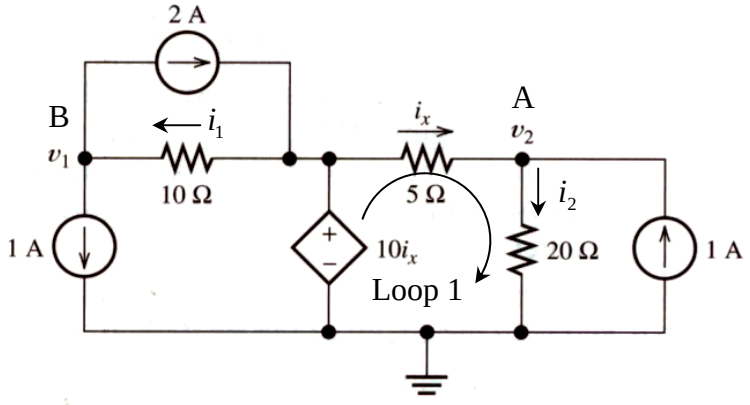
(b) The net current entering a super node is zero. Alternatively, the sum of the currents entering a super node equals the sum of the currents leaving a super node.

3. KCL at node A: $i_2 = i_x + 1$

KVL for loop 1: $10i_x = 5\Omega \cdot i_x + 20\Omega \cdot (i_x + 1) = 25i_x + 20, \quad i_x = -\frac{4}{3}A$

$\therefore v_2 = 20\Omega \cdot (i_x + 1) = -\frac{20}{3}V$

KCL at node B: $i_1 = 1 + 2 = 3A, \quad \therefore v_1 = 10i_x - 10\Omega \cdot 3A = -\frac{40}{3} - 30 = -\frac{130}{3}V$

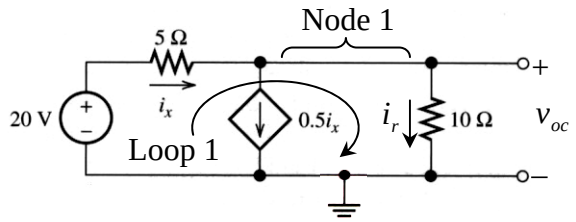


4. (a) Circuit with an open circuit:

KCL at node 1: $i_r = i_x - 0.5i_x = 0.5i_x$

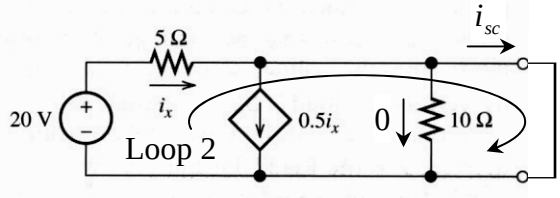
KVL for loop 1: $20V = 5\Omega \cdot i_x + 10\Omega \cdot i_r = 10i_x, \quad i_x = 2A$

$\therefore V_t = v_{oc} = 10\Omega \cdot i_r = 5i_x = 10V$



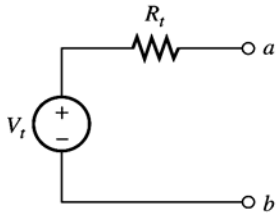
(b) Circuit with a short circuit:

KVL for loop 2: $20V = 5\Omega \cdot i_x, \quad i_x = 4A, \quad \therefore I_n = i_{sc} = 0.5i_x = 2A$

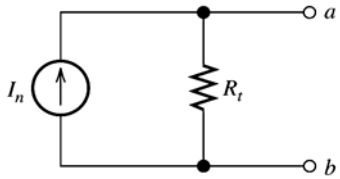


$$R_t = \frac{v_{oc}}{i_{sc}} = \frac{10V}{2A} = 5\Omega$$

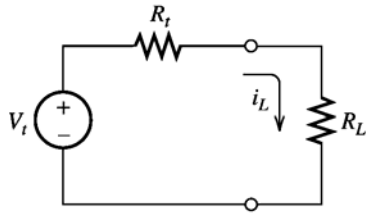
(c) Thévenin equivalent circuit



Norton equivalent circuit



5. (a) $P = VI = I^2R$, so the source power is $i_L{}^2 R_t$ and the load power is $i_L{}^2 R_L$.



(b) $Efficiency = \dfrac{i_L{}^2 R_L}{i_L{}^2 R_t + i_L{}^2 R_L} = \dfrac{R_L}{R_t + R_L}.$

(c) $\dfrac{R_L}{R_t + R_L} = 80\% = \dfrac{4}{5}, \quad R_L = 4R_t.$